



Causation mechanism of coal miners' human errors in the perspective of life events



Zhang Weihua*

School of Management, China University of Mining & Technology, Xuzhou 221116, China

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ABSTRACT

In order to effectively decrease the safety accidents caused by coal miners' human errors, this paper probes into the causality between human errors and life events, coping, psychological stress, psychological function, physiological function based on life events' vital influence on human errors, establishing causation mechanism model of coal miners' human errors in the perspective of life events by the researching method of structural equation. The research findings show that life events have significantly positive influence on human errors, with a influential effect value of 0.7945 and a influential effect path of "life events—psychological stress—psychological function—physiological function—human errors" and "life events—psychological stress—physiological function—human errors".

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1. Introduction

The unique nature of coal mines and the complexities of on-site mining mean greater risk for the coal miners [1]. However, with the strengthened safety supervision and the advanced mechanical mining technologies, mining safety has been looking up in China [2,3]. In 2012, the fatality rate per MT coal was mere 0.374. Despite the sharp reduction in severe mine accidents, sporadic accidents took place, one major reason for which were human errors [4]. Reason defined human errors as the individual conducted a series of planned psychological or physiological activities but did not reach his expected results, which mainly included errors in perceiving environmental information, errors in information processing and decision-making and errors in behavior output [5–7]. Vicent further divided the reasons leading to human errors into overload, errors in decision-making and abnormalities in human–machine interaction. Lately, with the advancement of mechanical application and production technologies, the human–machine interaction in production was constantly improved and human errors resulting from human–machine interaction abnormalities plummeted [4,6]. Meanwhile, however, miners, as the subjects in the production system, were inevitably exposed both physiologically and psychologically to the influences of various life events, therefore their consistency in ensuring mining safety was unstable [4,6].

At present, many research efforts were devoted into human errors and brought about certain fruits. However, most of the

researches were dedicated areas such as the analysis of the credibility of human factors, the model of human error control, the analysis of human error mechanism and factors affecting human error frequency [4–10]. All these studies concentrated on manifestations of human errors and procedure control and made no further attempts. Zhang and his colleagues proposed that cognitive psychology should be employed in studying the advanced stage of human error research [7], which gained support from researchers including Liu and Zheng [11]. Presently, studies based on such principles were few, most of which were focused on the qualitative expatiation and rarely were the quantitative studies based on collected data. Therefore, the relevant conclusions of these previous studies were subjective to some degree. Besides, previous studies focusing on factors affecting human error frequency confined their perspective to individual cognition, physiology, psychology and characters [6], lacking those on external factors such as life events. This paper attempts to offer an in-depth and systematic study of the factors leading to coal miners' human errors in the perspective of life events, thus providing a renewed perspective for mining enterprises in reducing human-error-led accidents and perfecting safety management.

2. Theoretical model and hypothesis

Based on the psychology and human error theory, this paper attempts to establish the theoretical model of human error caused by life events, coping, psychological stress, psychological function and physiological function.

* Tel.: +86 516 83995580.

E-mail address: dahuacumt@126.com

American psychologists Holmes and Rahe defined life events as “indicators of the tendencies of or practical needs for the individual’s lifestyle to change” [12]. Brown and Biricy thought “life events are events that generally easily arouse emotional disorders, often involving danger, fundamental changes in health and lifestyles or major success or failure” [12]. Since coal miners live in a volatile social environment, they inevitably encounter life events of diverse kinds, which are often unpredictable and universal. When miners are subjected to life events, especially accidents beyond their sustainability, their psychological balance will be disturbed and they will suffer from emotional fluctuations and psychological pressure. Therefore, this paper establishes the following hypothesis:

H1. Life events have significant direct-ratio influence on the miner’s psychological stress.

Compass and his colleagues defined coping as ‘the individual’s conscious efforts of will to adjust emotion, cognition, behaviors and environment when faced with stressful events and environment [13].’ When faced with life events, the individual will make cognitive evaluations of the nature, severity and his handling capacity of the events in accordance with his individual psychological traits and tendency, social supporting system, knowledge and skills. And he will select strategies to cope based on those evaluations. To alleviate the impact of life events on his psychological state, he will mobilize his internal and social resources to rebalance his mind [14]. If this fails, the miner will suffer loss of action and overpressure. Therefore, this paper establishes the following hypothesis:

H2. Coping has significant inverse-ratio influence on coal miners’ psychological stress.

Psychological stress is an integrated psychological state featuring constant stress driven by responses to life events, that is, a state of nervousness where the individual feels the pressure but cannot get rid of it [15]. According to psychological theories, excess psychological stress will lead to the declined psychological function (distracted attention and declined level of consciousness, will and working desire [16]) and the negative physiological responses (declined strength, stiffened body, sense disorders, memory disorders and mental disorders [16]). When the coal miners work with declined psychological function, their working desires fall, therefore they cannot consciously mobilize and adjust the attention, which means a declined physiological function. Therefore, this paper proposes the following hypotheses:

H3. Psychological stress has significant inverse-ratio influence on the miner’s psychological function.

H4. Psychological stress has significant inverse-ratio influence on the miner’s physiological function.

H5. Psychological function has significant direct-ratio influence on the miner’s physiological function.

According to Thurley’s “S-O-R” theory of human errors, the mechanism of human behavior could be summarized as a process where the organism (O) responses (R) when stimulated (S), that is, the combination of perception, judgment and action [17]. The life events encountered by miners, if not properly handled, will result in psychological overpressure, and further, declined psychological and physiological functions of the miners, which will interfere with the S-O-R mechanism in the miners. Difficulty in timely and accurately sending external information including working orders, equipments operating conditions, working environment to the their brains through their sense organs will lead to failure in the perception phase; difficulty in judging the information received based on their experience and knowledge will lead to failure in the judgment phase; difficulty in transmitting the brain-produced orders to limbs through nervous system so as to conduct proper control will lead to failure in the operation phase. Therefore, this paper proposes the following hypotheses:

H6. Psychological function has significant inverse-ratio influence on the miner’s human errors.

H7. Physiological function has significant inverse-ratio influence on the miner’s human errors.

H8. Psychological stress has significant direct-ratio influence on the miner’s human errors.

Based on the above hypotheses, this paper establishes the following theoretical model (Fig. 1).

3. Design of research methods

This paper employs the structural equation model (SEM) to conduct experimental tests of the above hypothetical theoretical model. A complete SEM includes a measurement model and a structural model. The measurement model depicts how latent variables are measured or conceptualized by their correspondent observed variables and the structural model describes the correlations among latent variables. Therefore, this paper formulates the measurement model through determining the latent variables and observed variables and establishes the structural model by figuring out the correlations among the latent variables.

3.1. Design of the method to get observed variables

As is shown in the theoretical model (Fig. 1), predictable exogenous latent variables include life events (ξ_1) and coping (ξ_2); endogenous latent variables include psychological pressure (η_1), psychological function (η_2), physiological function (η_3) and human errors (η_4). Drawing experience from the mature methods used in the previous researches, the questionnaire method is employed to determine the correspondent observed variable of each latent variable. In analyzing the questionnaire, Cronbach’s alpha coefficient

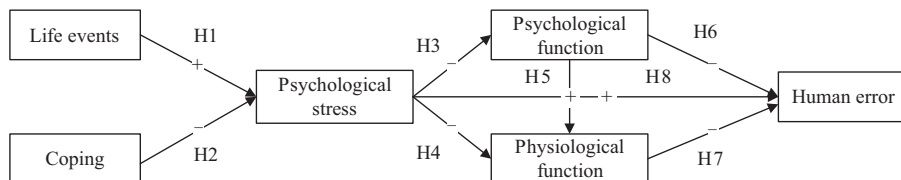


Fig. 1. Theoretical model.

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